THE FOOD AND FEEDING OF JUVENILE BENGAL MONITOR LIZARDS (*VARANUS BENGALENSIS*)[1]

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A sample of 29 juvenile *Varanus bengalensis* were examined for prey remains in the gut. Results show that most probably find several individuals of about two species of insect prey per day. While both sexes take the same prey species, males caputure a somewhat higher number of prey items per unit time. The most common prey are orthopterans and coleopterans. Weight of individual prey to predator weight is .0169:1 — a low ratio when compared to that known for other monitors, but probably due to the insectivorous feeding habits of the *Varanus bengalensis* juveniles.

INTRODUCTION

During September to December, 1979, the senior author was afforded the opportunity to study several aspects of the ecology and habits of two species of monitor lizards in northern India—*Varanus bengalensis* and *V. flavescens.* One of the projects suggested by the available material was a study of the food habits of *V. bengalensis.* This paper is the result of a joint study of that material by the two authors.

The study was prompted by (1) the fact that extremely little information is available regarding the food of juvenile varanids of any species (though the species studied by Pianka, 1968, 1970, 1971), are all less than 1 m total length, and (2) what little information is available on the food of varanid lizards is largely in the form of prey lists (Stirling 1912, Burden 1928, Waite 1929, Cowles 1930, Zakhidov 1938). Few publications concerning the feeding of varanids provide data useful in determining their predatory strategy; exceptions are Dryden (1965), Pianka (1968, 1970, 1971), and Auffenberg (1981).

Most published food data for *Varanus bengalensis* are very general (Smith, H. 1931, Deraniyagala 1931, Smith, M. 1935, Minton 1966). The most detailed study is that by Sharma and Vazirani (1977). In no case are results based on an examination of more than five individuals. The following study is based on the food remains found in the digestive tracts of 29 juvenile Bengal monitor lizards and records several previously unknown facets of the feeding biology of this species. While the number of specimens examined may be considered small, and the fact that they were obtained from supply houses less than entirely satisfactory, the chances of obtaining more material of this species (listed as endangered in IUCN Red Data Book and protected by Indian law) is extremely remote.

METHODS AND MATERIALS

After the law protecting *Varanus bengalensis* was passed, several Indian biological supply houses in the Agra area were left with a number of preserved individuals originally intended for sale to university anatomy classes. Because

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the species could no longer be sold, most supply houses discarded their stock of preserved *V. bengalensis* several years ago; some did not, and most of these had apparently been forgotten in the interim. The senior author visited each of these supply houses and requested that their old stocks of preserved specimens of this species be donated to this scientific project. Several houses generously responded, so that 29 juveniles were accumulated. They were sexed, measured, examined for a number of scale characters, and then dissected to obtain data on food in the gut.

Average snout vent length (= SVL) of the sample studied was 180 mm (range 155-286) and Av. weight 124.7 g. There was no significant difference in either SVL or weight between males and females. Estimated age of individuals in the sample was one year. The sex ratio was 1:1.

Stomach contents were kept separate from those of the large intestine of each individual. The food remains (often completely macerated) in each of these collections were identified as closely to species as possible.

Estimates of the number of individuals of each of the prey species eaten were based on the number of identical anatomical parts. The weight of prey species were obtained by weighing a sample of five average-sized complete adult specimens of each of these prey species.

Results

Number of Prey.—Only two lizards contained food in the stomach, suggesting that few individuals had eaten in the 48 hours previous to capture. On the other hand, 59.6 per cent of the lizards contained food remains in the large intestine. Assuming gut passage rate in *V. bengalensis* is the same as in *V. komodoensis* (4-6 days, 96-114 hr; Auffenberg 1981), over half had eaten during the last several days before they were killed.

The number of prey *items* in the two stomachs were 3 and 14. The number of prey species per stomach were 2 and 8. These data suggest that each daily feeding foray usually results in the capture of several different prey species, each represented by several individuals.

In those monitors containing food in the large intestine, the number of prey items varied from 1 to 273. The highest item numbers were represented by two cases in which many ants had been eaten. When these are excluded the prey items per individual range from 1 to 27 (Av. = 14.14). If this prey load represents a maximum of 6 days, as suggested by the *V. komodoensis* passage rates mentioned above, 2.12 prey items represent the normal stomach daily load.

Of all the males available for dissection, 64.13 per cent had food in their gut (stomach and intestines combined), with the range in number of prey items from 1 to 27 (Av. = 13.00, SD 7.49); and the total number of prey species in the gut of the same sex varied from 1 to 8 (Av. = 3, SD 5.33). Of the females available, 71.4 per cent had prey in the gut, with the number of prey items ranging from 1 to 17 (excluding those with ants, due to the large number of individual prey items represented per individual monitor in which ants occurred) (Av. = 5.29, SD 5.33), with the number of species per gut ranging from 1 to 3 (Av. = 2.29, SD 1.33). There is no significant difference between number of males and females with food in the gut, or in the number of prey species per gut. However, there is a significant difference in the means of the number of prey items in the gut of males and females (t test 2.61, df 48, $p = 0.25$), with males having a significantly greater number. Thus it appears

TABLE 1

NUMBER OF INDIVIDUAL PREY ITEMS EATEN BY JUVENILE *Varanus bengalensis*

Prey Species	Lizard Sex			Total	Percent of Total (no ants)
	Males	Females	?		
Coleoptera					
Tenebrionidae (*Gonocephalum*)	43	7		50	20.2
Carabidae	13	11		24	9.7
Elateridae	8	0		8	3.2
Staphylinidae	1	0		1	0.4
Cetonidae	1	6		7	2.8
Meloidae	2	0		2	0.8
Curculionidae	2	2		4	1.8
Scarabaeidae	5	1		6	2.4
(larvae)	2	1		3	1.2
Chrysomelidae (larvae)	1	0		1	0.4
Dermaptera	16	19	16	51	20.6
Hymenoptera					
Formicidae (*Campanotus*)	2	511		513	
Orthoptera					
Gryllidae	16	61	2	77	31.1
Nymphs	2	2		4	1.6
Gryllotalpidae (*Gryllotalpa*)	2	0	3	5	2.0
Acrididae (nymphs)	1	0		1	0.4
Arachnidae					
Scorpions	2	0		2	0.8
Centipedes (*Scolopendra*)	1	1		2	0.8
Totals	120	622		761	
excluding ants	118	111		248	100.0

that males and females probably hunt in equally diverse areas and capture an equally diverse number of prey species, but that males obtain a larger number of the same species than females do. This agrees with the behavioural data presented in Auffenberg (1979), showing that at least captive males of this species of monitor lizard eat more food and are generally more active than females of the same general size and age. Thus I suspect that in the wild, juvenile males of this species are probably also more active than females, travel further, or hunt more actively in the same amount of time.

Table 1 shows the prey species recorded in the guts, the total prey individuals of each in the total sample, the number of individuals per predator sex, and the per cent of the total. We found a total of 761 individual prey items, of which ants were the most numerous, and all were the same species—*Campanotus compressus*. The 513 ants recorded were found in five monitors, and in these the greatest proportion was found in two females (270, 240, and 1 per three females possessing ants, 1 ant was found in each of two males). Although the females may eat ants more commonly than males, it is clear that ants are often taken in large numbers at the same time. The fact that both soldiers and workers occurred in the samples suggests that nests of these ants were uncovered. Mertens (1942) speculated that the tongue may be used to transfer small food particles to the mouth. This is substantiated by observations made by the senior author of captive monitor lizards of the same species, which frequently feed on carpenter ants by licking them up individually.

Prey of the family Gryllidae were common in terms of number of individuals preyed upon. Both nymphs and adults were eaten, though the latter make up most (80%) of the total crickets taken.

Excluding ants, tenebrionids were the most commonly eaten. The differences between these and both dermapterans and gryllids are probably not significant. The overall number of prey items in the gut (to 270 if ants are included) was 1 to 54. The remaining prey items represent a second prey category of

TABLE 2

AVERAGE DRY WEIGHT OF MAJOR PREY SPECIES OF JUVENILE *Varanus bengalensis*

Prey species	Av. dry w. (g) (n=5)	wt	Number Eaten, range (Av.)		Total wt (g), range (Av.)	
Coleoptera						
Tenebrionidae	0.67	0.54	1–24	(9.0)	0.67–16.12	(6.04)
Curculionidae	0.19	0.16	2	(2.0)	2	(0.38)
Carabidae	1.21	0.97	1–4	(2.18)	1.21–4.84	(2.64)
Scarabaeidae	1.82	1.46	1–4	(2.0)	1.82–7.28	(3.64)
Dermaptera	0.46	0.37	3–16	(7.29)	1.38–7.39	(3.36)
Scorpions	9.96	7.98	2	(2.0)	19.91	(19.91)
Gryllidae	0.47	0.38	1–54	(8.3)	0.47–25.4	(3.9)
Gryllotalpidae	2.08	1.67	2–3	(2.5)	4.16–6.24	(5.2)

much less common prey species (1-4 per gut).

Size of Prey.—Table 2 lists the most common prey species taken, the average dry weights of individuals in each prey category, the average number eaten when preyed upon, and the overall range and average total dry weight of each of the prey species found in each monitor. These data show that (excluding ants) the dry weights of individuals of common prey species taken by juvenile varanids vary from 0.19 to 9.95 g (curculionids to scorpions), representing an overall weight increase of 523 per cent from the smallest to the largest prey. The mean individual prey weight is 2.11 g, and the overall range in prey-to-predator weight is 0.16 to 7.98 per cent (Av. = 1.69%). The mean total weight of each prey species expected in the gut varies from 0.38 (curculionids) to 19.21 g (scorpions), with a mean of 4.88 g, or 3.91 per cent of the total average predator weight.

The largest prey are scorpions, though they are not often eaten. Gryllidae and Tenebrionidae are probably the most important prey taken in terms of their size and number.

Prey Habitat.—Table 3 shows that of the 10 most common prey categories, most (60%) are found in and under decaying vegetation debris, and one moves back and forth through shallow burrows in the soil. Thus, 70 per cent of the prey categories are represented by secretive species, all of which can be obtained at or near the surface. Observations on captive

TABLE 3

GENERAL HABITAT AND FOOD OF INSECT PREY OF *Varanus bengalensis.**

Prey Species	In or under (+) decaying vegetation debris	Injurious (+) or not (–) to crops
Coleoptera		
Tenebrionidae	+	++
Carabidae	+ – (varies)	+–
Scarabaeidae	+ –	+–
Curculionidae	– (on leaves)	+
Elateridae	+	–
Meloidae	– (active on surface)	+
Chrysomelidae	– (on leaves)	+
Dermaptera	+ (active nocturnally)	–
Orthoptera		
Gryllidae	+ (active nocturnally)	+
Gryllotalpidae	underground, secretive	+

* After Lutz, 1948.

V. bengalensis make it clear that the most prey are obtained by rooting through surface debris with the snout, or by scratching through it with the front feet. The habit of using the snout so extensively in prey-seeking may be an explanation for the posterior position and slit-like narial opening in this and certain other monitor species. Only 2 of the 10 prey categories (both are beetle families) are not found near or on the soil surface, but on leaves.

The same table also shows that almost all prey categories are injurious to agricultural crops. Dryden (1965) came to the same conclusion regarding the prey of *Varanus indicus* on Guam.

Vegetation as Food.—Though both Parry (1932) and Sharma and Vazirani (1977) implied that *Varanus bengalensis* occasionally feeds on vegetation on the basis of stomach contents, there is no behavioural data that they do so. While eating animal prey that is either dead or alive, vegetal debris is regularly ingested accidentally and this apparently accounts for the vegetation sometimes found in the stomach. However, *Varanus grayi,* an arboreal species from the Philippines, regularly feeds on several types of fruits (Auffenberg 1979), and *Varanus prasinus,* another arboreal species. from New Guinea, has also been reported to occasionally feed on bananas in captivity (Mertens 1942). Other than these two species, no other members of the family Varanidae are known to deliberately feed on any vegetation.

Discussion

The data presented above show that juvenile *Varanus bengalensis* are probably completely insectivorous. This agrees with the data presented by Sharma and Vazirani (1977), for a very small sample of the same species from the same general part of India, and taken in the same part of the year. Additionally, in both studies the Order Coleoptera makes up most of the diet, with tenebrionids the major beetle group represented. Sharma and Vazirani (1977) also reported that termites are occasionally taken. This largely insectivorous feeding habit of juvenile *V. bengalensis* provides a rather low prey to predator weight ratio (.0169:1). While no accurate comparable data are available for adult Bengal monitor prey weight preferences, Minton (1966) listed proportionately larger prey in five adults from West Pakistan. Thus large individuals can be expected to have a larger prey to predator weight ratio. The same trend has been demonstrated in *Varanus komodoensis* (Auffenberg 1981), in which the largest adults, who often attack and kill deer, some weighing up to 204 kg (= prey to predator wt. 365:1), or even water buffalo up to 340 kg (= ratio of 608:1). These predator-to-prey ratios are probably the highest of any lizard species. However, the ratio for juvenile *V. komodoensis* (.0208:1) is approximately the same as in the present sample of *V. bengalensis,* though somewhat higher because juvenile Komodo monitors also feed on small lizards.

Though literature data are scanty and rarely comparable, I conclude that varanids may generally exhibit a higher predator-prey ratio than other lizards, for, in additon to *V. komodoensis* (Auffenberg 1978, 1981), proportionately large prey are also eaten by several other varanid species (Dryden 1965, Pianka 1968, 1970, 1971).

The data presented above, plus general experience, suggest that there are relationships existing between the mass of reptile predators and their prey that have not yet been brought to light by previous studies of reptilian food habits. These relationships may change from juveniles to adults in some species, and show

no change in others. Considerable differences in these relationships are expected between various reptilian groups. They probably constitute one of the most important factors in feeding behaviour and functional morphology of feeding mechanisms.

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